

Hydronic Radiant Floor Heating

Long ago, the Romans used radiant floor heating in their bathhouses. For centuries, the Koreans heated their royal palaces and traditional homes in this manner. Today, radiant heating technology has been improved and can be used in all or part of our homes.

What is radiant floor heating?

Radiant floor heating is a method of heating your home by applying heat underneath or within the floor. Comparable to warming yourself in the sun, this type of heating warms objects as opposed to raising the temperature of the air.

There are three types of radiant floor heating: hydronic, electric and air. This *About Your House* document focuses on hydronic (water) radiant floor heating.

Brought to North America post World War II, the first generation of North American systems met with several mechanical failures. The introduction of carpeted floors reduced the system efficiency. Today, significant improvements have been made in both the heating component and the system design.

Hydronic radiant floor heating is a system of plastic or metal tubes/pipes laid within a floor that carries hot water into specific rooms or “zones,” dispersing the heat through the floor surface (see Figure 1).



Figure 1. Hydronic radiant floor heating tubing laid out in specific heating pattern prior to concrete pour. Photo courtesy of Ready Mixed Concrete Association of Ontario.

The cooler water returns to the heat source where it is reheated and sent out again in what is known as a “closed-loop system.” The pipes can be encased in a concrete slab, a concrete or gypsum cement overpour, laid into thin grooved panels that nail on top of a subfloor, or suspended below a wooden subfloor using metal fins fastened under the floor surface (see Figure 2). The heat output is determined by pipe spacing, water temperature, flow rate and floor covering. The heat output must be calculated to meet the heat loss demands of the home.

One type of tubing commonly used is a new leak-resistant, non-toxic, high-temperature, flexible piping called cross-linked polyethylene (PEX). PEX is a durable tubing that doesn't become brittle over time and isn't affected by aggressive concrete additives or water conditions. PEX has been used in Europe since the 1970s and was introduced to North America in the early 1980s.

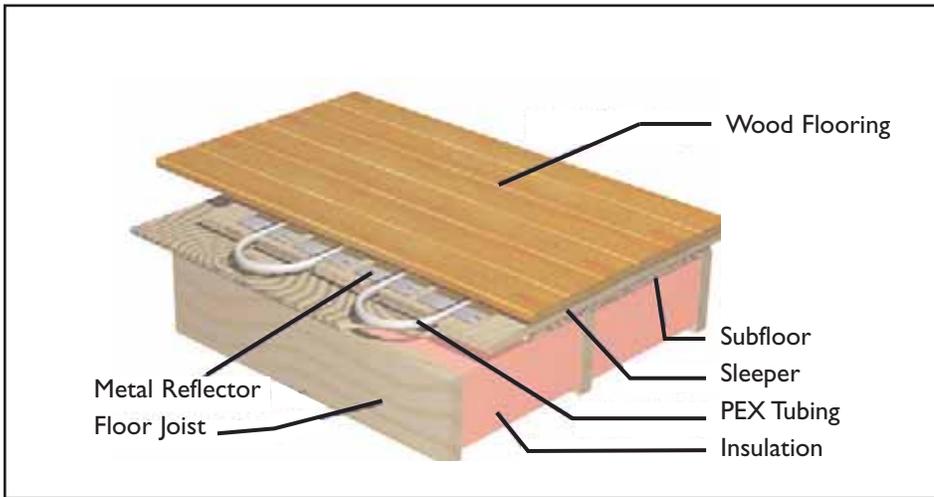


Figure 2. Suspended in subfloor. Image courtesy of Wirsbo Co.

Is this type of heating available in both new and existing homes?

Yes. While the system can be easily designed and installed in new construction, homeowners wishing to renovate may incorporate hydronic radiant floor heating throughout the home, given certain conditions exist:

- the building structure can support the additional weight of the concrete/cement overpour, or
- the underside of the subfloor is accessible, or
- if being added to the basement, there is enough height for a concrete overpour above the insulation. (If the concrete floor is already insulated below, additional insulation is not necessary.)

Entire House Versus Selected Rooms

Homeowners can choose to install hydronic radiant floor heating throughout the house, or in selected rooms (see Figure 3). The most popular rooms with this type of heating are the bathroom, kitchen and living room—rooms where the most time is spent. If only selected rooms have this type of heating, then a separate heating and ventilation system is required to heat the remainder of the home. The system can also be “zoned” so that there are temperature controls for each area.

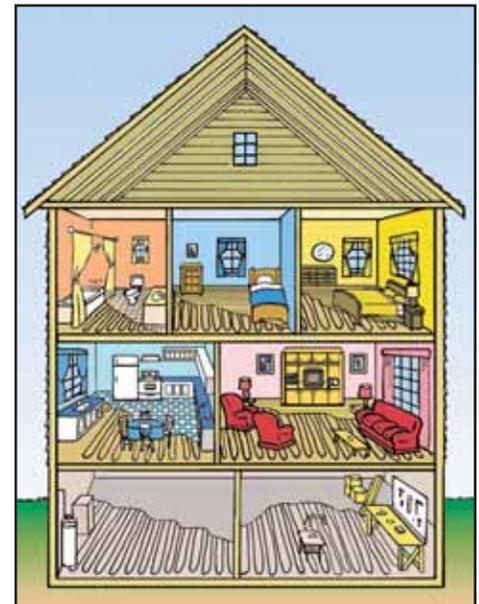


Figure 3: Hydronic radiant floor heating throughout a home. Note: Pipes are not visible when installation is completed.

Design

Prior to the installation of a system, a qualified floor-heating specialist should make a heating-load estimate of your home on a room-by-room basis. The heating-load estimate will assist in an efficient system design. By placing the tubing in specific patterns and spacings, the system can accommodate the insulation of the room/home and flooring choices.

Once designed and installed, a copy of the design should be given to the homeowner, should pipes/tubing need to be located at a later date. When renovating, extra care must be taken that piping or tubing not be punctured.

Exposed surfaces that conduct heat well are best for radiant floor heating, such as finished concrete or ceramic tile. It should be noted that if any later flooring renovation is undertaken, the hydronic radiant floor heating installer should be notified to make any required adjustments to the heating system. For example, the water temperature of the heating system would need to be adjusted if there was a change from a bare or painted finished floor slab to ceramic tile, or wood flooring or to carpet with underlay. Wood flooring and thick carpets act as an insulation blanket, restricting upward heat flow and reduce the efficiency of the system.

System Components

There are three components to this heating system: a heat source, a distribution piping system and controls. The heat source in hydronic radiant floor heating is usually a boiler or a hot water heater, but other heat sources can be used too. The energy used to heat the hot water can be natural gas, oil, electricity, propane, wood or solar hot water collection.

A circulator pump near the water supply manifold moves the water from the mixing valve to the supply manifold into the distribution piping system (tubing) inside the floors. Properly designed, this delivers even heat to rooms. A properly designed radiant floor system will not exceed 29°C (85°F).

To select how warm or cool a room or home will be, controls are required to set the system to a particular temperature. A manifold system with thermostat or aquastat switches typically located in an accessible wall cavity provides a series of simple valves that are used to regulate the flow of water through each zone. There is a caution not to exceed the recommended maximum temperature as it could warp solid hardwood flooring and cause stress to the system.

Installation

There are three choices of installation:

1) Slab-on-grade system:

One example of a slab-on-grade system is PEX tubing attached to a wire mesh or clipped onto rigid Styrofoam insulation. Concrete is poured over the piping or tubing at the ground “grade” level. The slab must be insulated from the exterior side of the floor all the way to the slab edges.

2) Thin slab system:

- a) The floor heating tubing is fastened above the subfloor and is covered with lightweight concrete or self-levelling gypsum cement underlayment. The floor ranges in thickness from 3.2 to 3.8 cm (1.25 to 1.5 in).
- b) Another version is to sandwich the tubing between the subfloor and the finished floor. This raises the floor only 1.3 cm (1/2 in). There are a variety of new underlayment panels that hold the tubing in place and incorporate aluminum transfer plates to improve heating performance.

3) Dry or “Plate” system:

Tubing is attached to the underside of the subfloor, also known as a below-deck or joist space dry system. In cold weather climates, tubing should be attached with aluminum transfer plates and both well insulated for improved performance. Without the insulation, the warmth will disperse into the basement. It is also possible to have an above-deck dry system, where heat transfer plates are supported by sleepers.

It is recommended that a licensed contractor install the heating system.

Costs

An approximate cost of an installed hydronic radiant floor heating system by a licensed mechanical contractor can range from \$600 to \$800 per approximately 100 square feet. This cost can be more or less depending on specific heating requirements and energy efficiency results. In addition to the heating system, a mechanical ventilation system is required in the house.

Maintenance and Repairs

It is recommended that annual maintenance be done on mechanical equipment such as the pumps, hot water heater, controls etc. If there was a problem or failure, it is commonly found in these mechanical parts. It is recommended that the installer be contacted for annual maintenance.

For repairs to the system, the homeowner should contact the installer. Be sure to have your design plan available for tubing location.

To avoid unnecessary repair work, all equipment must be used and maintained in the manner in which it was designed and installed. Homeowners disconnecting controls or moving pumps can find themselves requiring repairs and possibly voiding their warranty.

Lifespan

While the heat source in a properly maintained system can last for as long as 30 to 40 years, PEX pipes set in the floor are expected to last more than 50 years. (Some test results indicate life expectancies of 200-300 years.)

Warranty

There are two types of warranties: a Manufacturer's Warranty and an Installation Warranty.

Most manufacturers' warranty policies are strongly dependant on certified and qualified mechanical contractors completing the installation. All require Code regulations be followed for the jurisdiction in which the home is being built. Some manufacturers also require that specific devices be field installed by the mechanical contractor to ensure full warranty coverage. There is no difference in warranty between new construction and renovations, and the warranty should be given to the consumer in writing.

Installation warranty varies on the heating contractor and their warranty policies. There may be a difference in warranty between new home construction and renovations by the heating contractor.

Benefits

Comfort

Radiant floor heating provides even, comfortable, warmth as there is less air movement with this type of system. There are no drafts with this type of heating, unless it is through the building envelope. The thermal mass (concrete floor) evens out the temperature fluctuations. The floor is warm to the touch.

Energy-Efficiency

Many manufacturers claim that radiant floor heating is more economical to operate because the temperature setting may be set to 20°C (68°F) rather than the usual 21-22°C (70-72°F) as required by other types of systems. A study by CMHC (*Thermostat Settings in Houses with In-Floor Heating*, #01-106) has shown that people tend to keep their thermostats set the same as if they had a forced air system. Even so, the warmest air is at the floor where it is desired (and not at the ceiling), and there is reduced heat loss through the ceiling and walls.

Zoning a variety of rooms with the options for different temperatures has the potential to reduce energy consumption.

Energy Source Compatibility

Since radiant floor heating has a low operating temperature, a wide range of sources can be used to heat the water—a ground-source heat pump, a condensing or non-condensing boiler, solar or even district heating.

Quietness

The system is quiet because a properly-sized circulator pump, used to slowly move the water, is almost inaudible. The loudest sound in the system is usually the gas or oil burner.

Cleanliness

Unlike conventional forced-air furnaces, radiant floor heating has no ducts or radiators to contribute to dust collection or movement. Note: duct work is required for the mechanical ventilation system or air conditioning.

For residents with allergies, the reduction in dust movement may be beneficial.

Room Function

Hydronic radiant floor heating is virtually an invisible system. Without baseboard heaters, forced air registers etc, furniture layout is not restricted by the heating system. Bathrooms or special use areas with hard floor finishes are well suited to this type of heating.

Cautions and Solutions

Due to thermal mass, the system may be slower to respond to temperature changes. Overheating can occur in poorly controlled or zoned systems. The system is not designed to have the temperature frequently adjusted.

Night setbacks are not practical in most situations as the system is slow to react.

Ventilation must be done separately. As air conditioning cannot be used in ventilation-sized ducts, window/wall air conditioning can be installed or room-by-room split systems can be used. Additionally, high-velocity air conditioning systems that use small outlets in ceiling or walls have proven very compatible with radiant floor heating operation.

Extra support may be needed for the weight of thermal mass topping on a wood floor. If the building structure can't support the weight, then the dry plate system can be considered.

This is not a do-it-yourself project. It requires professional installation, maintenance and repair. Having professionals do the installation will allow you to have the best performance and warranty on the heating system.

More Information

Heating contractors, heating equipment wholesalers and heating associations (for example, Canadian Hydronics Council and the Hydronic Marketing Group) can provide specific information on hydronic radiant heat products. The Yellow Pages™ or the Internet provide a variety of sources.

To find more About Your House fact sheets plus a wide variety of information products, visit our website at www.cmhc.ca. You can also reach us by telephone at 1-800-668-2642 or by fax at 1-800-245-9274.

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